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Model for Geologic Risk Management in the Building and Infrastructure Processes

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Abstract

The geologic risks management is a process that requires to follow the tendencies of the new models of technological innovation. Nowadays it becomes necessary to elaborate an specific model for the management of the geologic risks, that is adapted to the peculiarities of the current development of the building and infrastructure systems; and allow the use of the current tools as the GIS, Wombs, Analysis Cost Benefit, etc., for the organization and the control of the knowledge management and final quality of the executed works. To model with the processes management could be an alternative form before this task. Proposing in this occasion a variant to negotiate from this perspective the management of geologic risks in the building and infrastructure processes.

Keywords: Model, risks, management, geological hazards, process management, buildings, infrastructures.

Introduction

According to the resulting comprehensive geological science, many scientists in other fields tend to erroneously point to some primary or secondary geological events as not owned by or for study by geologists. This interpretation of the insufficient knowledge of geology as a science, mother of geosciences, and the fields and branches of this science. A summary of the sources suggests that, in principle, the geology is the science that studies the formation and origin of the Earth and its component materials inside and out, as well as, the study of all phenomena and physical and chemical processes natural, and its evolution over time, taking place on the planet Earth from its own emergence, focusing greater focus to those that occur in its outer part, or the crust.

Understand then, for example, the relationship between atmospheric phenomena and their impact on the earth's crust are studied by this science, or that relations between phenomena that originate within the earth with clear consequences in climate and our atmosphere, are also studied by geology, is a logical question for geologists. So also the actions performed by men and affecting one or more components of the earth's crust and the evolution of terrestrial flora and fauna and their footprints on the rocks, are also under consideration, among others, science geology.

Important aspects of this science are the geological processes and phenomena, also known geological events. The geological events taking place on planet Earth, and create transformations that occur in a slow or sudden. However, each may be equally fatal to society depending on a number of factors that are discussed below.

The planets own forces are born of the Earth, but project their effects in different ways in the land surface and the outer space. These forces include gravity, magnetism, physical-chemical reactions and geological processes associated with them. Taken together generate the tectonic plate movements, surveying and land decreases, the eruptions of volcanoes, geysers and fumaroles, springs, earthquakes, tsunamis, changes in relief, the secular changes of climate and a varied range of events related to the formation and transformation of substances and the landscape. In summary, internal forces of the planet determines the landscape of the earth's surface, whose influences on the environment and life are crucial for the present and the future of society (Iturralde-Vinent, et al, 2006).

Slow or cumulative events are those that act over a long period of time, so that its effects are evident by inspection. The assignment to the environment and society of these events occurs through the accumulation, in addition, tens of thousands years. For example, karst processes, where cavitations occurs and subterranean (popularly known as "caves"), changes in the relief surface (hummocks, among other forms) (Figure 1), or the presence of small concentrations of substances harmful in rocks, soils and natural waters, which were not detected by specific studies, and they can concentrate to unhealthy levels due to the consumption of water and plant to be drawn from these media.

Fig. 1. Karst formations, wooded hills of the Viñales Valey Pinar del Rio, Cuba. Photos: grind León, 2004, http://www.mappinginteractivo.com/plantillante.asp?id_articulo=815

Other events are slow secular movements of the ground, which typically occur at speeds that are measured in millimeters per year, but eventually come to cause major changes in the topography and buildings affect the coast, or over the rivers. By contrast, sudden event, usually catastrophic, are those that occur by the release in a short space of time, some energy inside the Earth and its combination with external phenomena, resulting in volcanoes, earthquakes (Figure 2), landslides, mudslides, floods, etc. (Iturralde-Vinent, et al, 2006).

Fig. 2. Sudden geological event. Earthquake Haiti, registered on January 12, 2010 at 16:53:09 local time (21:53:09 UTC) with epicenter at 15 km from Port au Prince, Haiti's capital. Views of National Palace and collapsed buildings in downtown Port au Prince.
http://es.wikipedia.org/wiki/Terremoto_de_Hait%C3%AD_de_2010

Hence, to know what kind of events can occur in the future in a given region, although not known exactly when and at what level can occur, is an activity of fundamental importance in guiding the development of a region, so that the impact of these events is the minimum possible and do not pose a disruption to the social and economic development of it. Knowing the potential effects and / or losses that may occur in the social and material allows within development plans and investment programs, you can define measures to prevent or mitigate the consequences of future disasters, whether through involvement in the occurrence of the event, if this is possible, or modifying the conditions conducive to its effects occur.

Geological risks

Geological risks are part of a broad set of risks that would be encompassed between environmental hazards, and grouped into classes according to their origin. The definition of geological risk has been addressed by several authors. One of its early definitions, formulated by the U.S. Geological Survey in 1977, states that geological risk means any geological condition, process or event which represents a potential threat to the health, safety or welfare of a group of citizens or functions of a community or economy. Geological risks cannot arise from simple description of the material or natural processes. Not conceive, either, regardless of the purpose for which they can cause on people, on their work or in general on the ecological balance (Brusi, 2003).

According to Ayala (1992), geological hazards are those processes, events or situations that take place in the geological environment and can cause damage or harm to communities or infrastructure that are vulnerable zones occupying a territory. Also understood as a process, situation or event in the geological, natural, induced or a mix that can generate economic or social harm to any community, and whose prediction, prevention or correction geological criteria are to be employed. Another definition are understood as a circumstance or situation of danger, loss or damage, social and economic, due to geological condition or a possibility of occurrence of geological process, induced or not. (Ogura - Macedo Soares, 2005). It is also distinguished, which are defined as processes occurring within the sediment (building, gas generation, break-cementing ,...) and require no action by external actors and those who are conditioned by the action of some external factor, natural (volcanism, uplift, subsidence, tectonic collapse, diapirism, currents, tsunamis, hurricanes...) or artificial (fluid extraction-gas-or oil, etc).

They all agree that geological hazards can be caused by natural or induced. In this sense, there are situations in which man's interaction with the environment that creates a potential risk situation, since human action itself has a "trigger" mechanisms to natural hazards or natural geological events could pose a or generate social harm and / or economic (Orberá - Ramirez, 1994). Geologic events that could represent potential threats to society, characterized by its unpredictability and its deadly consequences, but more dangerous is the degree of ignorance that exists at various levels on the types of risks they generate. Several authors have worked on the lines of classification of geological hazards, most of them agree classified according to the conditions that gave rise to them, namely:

- Natural geological risks
- Geotechnical risks.

Geological risks of natural kinds are those that are not produced at source by the hand of man, although could empower, they can originate from inside the Earth because its structure and together are known as endogenous or come from outside and are called exogenous. A summary of the literature describes them according to exogenous or endogenous origin is as follows (Galban, 2009):

Endogenous Geologic risks	Earthquakes, volcanic eruptions, liquefaction or liquefaction, tectonic movements, Tsunamis, karst, natural gas and hazardous substances, hydrothermal mineralization, cracks, cavities and landslides collapses, expansive soils, land subsidence
Exogenous geological risks	Storms, hail, cyclones, tornadoes, coastal flooding, river flooding, overflows of rivers and streams, erosion and sedimentation, impact of meteorites, salinization, desertification and drought, wind erosion, landslides, rockslides, avalanches

The geotechnical risks are induced geological hazards and enhanced by human error of calculation and lack of prevention in civil engineering. O is for errors of calculation and estimation of physical - mechanical properties of the soil, the failure of natural geological processes and phenomena and to non-works adaptation of certain parameters of resistivity, with the actual probability of occurrence of disastrous events natural or technological. And those caused by population growth, intensive agriculture in unsuitable areas, lack of evaluation of different types of long-term effects, etc. (Galbán, 2009).

Too many examples of risks induced by human activity, some examples include: landslides resulting from the change in the balance pending the construction of roads, broken dams or reservoirs (Figure 3), the subsidence of the land by mining, overuse of aquifers or tubing associated with water pipes, earthquakes triggered in rapid filling of reservoirs, settlement, subsidence and cracks of buildings on soft ground, among others.

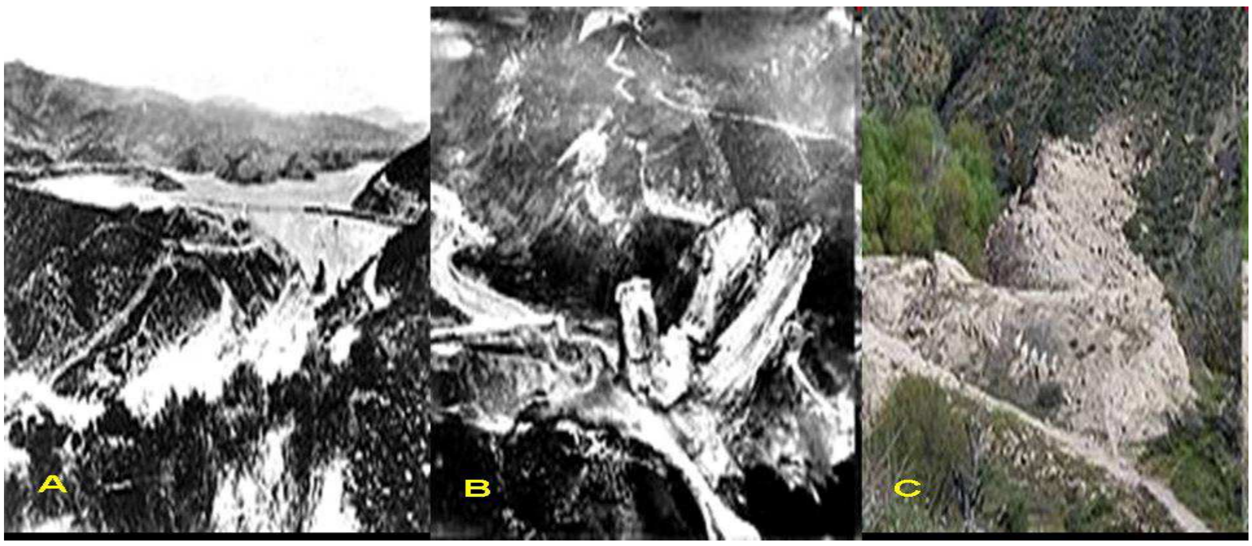


Fig. 3. Saint Dam Disaster. Francis, Francis, Los Angeles County, California, USA. Completed in 1926, the March 12, 1928, catastrophically failed due to geotechnical calculation errors during execution, killing more than 600 people. _Francis_ Dam Images from the start of the gap (A), after the disaster (B) and current image of the remains of the dam base (C). Http://en.wikipedia.org/wiki/St._Francis_Dam

The different types of geological hazards can interact with each other, and in the present predominance of one other side effect, which can complicate the situation and increase the vulnerability of the object of work in question. Because we cannot conceive without independent analysis finally perform a risk assessment as a system, supplementing these with geophysical, geodynamic, geomorphological and hydrogeological risk maps, etc.), Which in the literature does not appear specified in this way, although if certain risks related to or associated primary and secondary or used geographic information systems to determine a certain level of risk.

These questions denote that the geological risk in terms of construction and infrastructure projects, whether it is characterized, it is also necessary that depending on the use of this knowledge, take administrative measures and technological lead to ensure a certain level of safety therein.

The geological risk management in the building and infrastructure processes

Management is a modern concept, an issue that brings together aspects such as research, planning, organization, evaluation, management, analysis, implementation, monitoring and control (Kootz, 1998). Meaning that, properly inserted according to mitigate geological hazards, is a very useful working tool in the construction processes and infrastructure.

Considering all the prerogatives analyzed, taking into account the concepts related to the previously defined geological risk is defined for this investigation and management of geological risk, the activity which is responsible for the studies to be made of the phenomena or processes related to land and geodynamic processes or phenomena induced by human activity that affect projects and / or works of engineering, civil infrastructure, situated or in the future be located on the ground, so that these help plan, organize, manage, evaluate and control the organizational measures, techniques or technology that are issued for these projects or works, aimed at preventing or mitigating the effects of disasters caused by geological events of natural or anthropogenic (Galbán, 2009).

More broadly we can say that the geological risk management is performed to predict the consequences (risk) that future geological phenomena and natural or induced processes (risk) will have on a particular work or project which conceived man takes implicit or no transformation of reality (vulnerability) and therefore it becomes necessary to make organizational and technological measures to reduce its impact (management). (Galbán, 2009)

The biggest problem is that risk management is a problem internationally long term, decision makers have not always been particularly good at planning long-term development, or have spent much money in reducing these long-term risks (Monge, 2003). Therefore, precisely because their role is aimed at carrying out certain transformations of reality, needs to be contextualized and based on this pose a mechanism enabling the extent of the real possibilities of each country.

The risk may generate an infrastructure construction project and may be permanent or recurrent, affecting the daily lives of people and possibilities for development of an area or region in general. Also a risk that translates into a disaster, the event must be of a very large, as in some cases a series of small events, caused or enhanced by the construction of an infrastructure project may be more disastrous one of considerable magnitude. Similarly, a small phenomenon may be a warning that conditions are brewing risk in the future, may lead to a disaster of great magnitude.

The effect of construction and infrastructure projects in the generation of risk can occur in two ways: In the process of construction and operation, when trigger reactions of nature such as floods, droughts and landslides, especially when they cause deforestation, Inadequate management of soil, drainage and flood areas, wetlands, or artificial fillers between some elements. And the other way to generate risk is due to the permanent exhibition of the construction projects and infrastructure to natural geological phenomena induced which multiplies the effects on people and ecosystems in general (Monge, 2003).
To reduce the risk in the construction processes and infrastructure can be put in place, both prevention and mitigation, so that the effect is minimal. The prevention is to avoid or prevent natural events or generated by human activity are causing disasters. For its part, mitigation is the result of an intervention designed to reduce risks, trying to change the nature of the threats, in order to reduce vulnerability, so that it would mitigate the potential damage on the life and property (Cardona, 2001).

Correspondingly, one should consider that any measures designed to reduce or eliminate a risk, is closely related to processes in the medium and long term established for the development of a country or region, why should be incorporated into programs upgrading of enterprises implementing construction projects, or what is the same, should be incorporated into a management process, a process that should be developed or designing using different measures or tools. Today, these measures fall into two basic types:

- Structural measures.
- Non-structural measures.

Structural measures of prevention and mitigation are employed engineering works to reduce or lead to "acceptable" levels the risk that a community is exposed. They run directly on site and can be classified as preventive or corrective control. Its construction requires engineering design and optimization of resources, as well as, an Environmental Management Plan that will enable the reduction of the impact generated (Collective of authors. 2005).

There are several types of structural measures for treatment of landslides, erosion, floods, torrential floods, earthquake damage, among others, some of them are:

For landslides: The removal and / or shaping the contours of the ground or slope, which is performed in order to increase its stability, an issue that can be achieved by building trenches stabilizers, shares of terracing, coated plants or artificial among others.

For river erosion is primarily used coating with mulch, waterways, infiltration trenches, among others. For flood expansion works are performed or misuse of causes of rivers, building dikes and dams, etc. For earthquakes, for example, structural reinforcements are made in buildings by applying methods of geometric configuration, such as the static equivalent method and the modal analysis method, combinations of shapes are made, certain factors are calculated using both the depth and the area of foundations and reinforcements that are necessary to implement these, including specifications for embankments, slopes and near buildings, among others.[1]

These measures will positively impact the environment, quality of life of people living in areas at risk and during the construction phase generate employment. However, they can affect the health of the population, the lifestyle of the community and the mobility of pedestrians and users, and can generate negative impacts on different environmental components in each phase of construction of the project, therefore requires the implementation of actions to minimize these impacts (Collective of authors. 2005).

One way to force developers to implement certain structural measures during the execution of works, is through the adoption of codes or construction standards. In most countries, were adopted in various standards or codes that in one way or another to geological risk management processes and infrastructure construction, within these processes and focused on building and infrastructure, meet the standards for earthquake resistant construction, the project documentation, execution of works, geotechnical standards, among others. These rules indicate what calculations during the execution should be performed, how they should implement certain measures, among other things.

Non-structural measures are the most simple and important, and the most used around the world since ancient times. These bring together a set of functional elements related to physical planning and land use, technological tools, education, observation, legal, administrative, among others, which also help manage geohazards indirectly, within which include:

1. The design of models, methodologies, strategies, software, among others, to study, assess, manage..., management of geological risks.
2. The planning of land use, and with this construction that they are running.
3. The legislation of environmental factors that influence the management of risks.
4. The incorporation of preventive aspects of the budgets of state and private investment.
5. The organization of national and international scientific networks techniques for the investigation of the behavior of different events and associated risks, as well as project development and exchange of experiences.
6. The organization of monitoring systems and early warning.
7. Other specific measures depending on the types of risks.

There are other methods as those used in the assessment of environmental impacts, such as checklists, matrices, networks, cost / effectiveness / benefit and multi-dimensional models, which could be adapted to estimate the risk (Clarke, 2001) also providing rigor and accuracy requirements needed in the construction processes and infrastructure.

Besides this, it is always necessary to deepen local knowledge, timely, necessary dig into the specifics of each region, and that includes climate, geology, anthropomorphism, history, population characteristics, intent of use, etc., Or for the management of geological risk, one must also have completed certain steps of knowledge acquisition, both in individuals who perform the management and the institutions responsible for the investment (Galbo, 2009), all in an environment of multidisciplinarity.

A current variant is the adoption of models. A model is the result of the process of generating an abstract representation, conceptual, graphic or visual phenomena, systems or processes to analyze, describe, explain and simulate these phenomena or processes. [2] Today's systems or models of technological innovation are becoming increasingly complex. The assimilation of new technologies is not a passive, nor is achieved only by training the technical staff and operators in other countries as often happen. They need a culture around these technologies, an entire local culture in which staff training is based on domain knowledge and in depth, the laws and principles that govern it. This allows not only operates efficiently, but face new and unexpected situations, make necessary adjustments and innovations creatively develop increased on the same (Group of authors. 1999).

On the other hand, it is known that many scientific results in terms of disaster risk management are not applied in business practice, in many cases, issues with economic and institutional factors, characteristic of the international situation and other by administrative status, knowledge, organization, control management (Galbán, 2009). This is compounded by the low disclosure in the world of the results obtained by many scientists for its widespread use, the virtual absence of focal points, and the need to develop an awareness and appropriate calculations as to the levels existing geologic hazards and risks.

Processes management and geological risks management

A late of the eighties of last century, and derived from the need to increase the quality of economic and productive processes of enterprises in the developed capitalist world, there is a new management tool, which initially was called or process management process approach, this tool, in the year 1994 was adopted by the ISO as a standard for improving quality management, ISO 9001. Since its emergence has had several subsequent versions in 1998, 2000, 2001, 2003 and most recently in 2008.

Process management can be conceptualized as how to manage the entire organization based on the processes, these being defined as a sequence of activities to create added value on an entry to get a result and an output which in turn satisfies customer requirements (Negrin, 2006).

The process approach is based on:

- The structuring of the organization based on customer-facing processes.
- The change of the organizational structure from hierarchical to flat.
- Functional departments lose their raison d'etre and are multidisciplinary groups working on the process.
- Managers and supervisors fail to act and behave like cowards.
- Employees focus more on the needs of their customers and less on standards set by his boss.
- Using technology to eliminate activities that do not add value.

The process approach requires a logistical support, which enables the management of the organization from the study of the flow of materials and associated information flow from suppliers to customers. The customer orientation, or provide the service or product for a given level of satisfaction of the needs and requirements of customers, represents the fundamental gauge of corporate profits, thus obtaining an efficient supply management and timely response to the planning process.[3]

Companies and organizations are as efficient as are their processes, most of which have become aware of what was previously stated, have reacted to the inefficiency representing departmental organizations, with their niches of power and excessive inertia to change, promoting the concept of the process with a common focus and working with an objective view on the client. [4] The main advantages of this approach are:

- Align organizational objectives with the expectations and needs of customers
- Shows how to create value in the organization and
- Points out how they are structured flows of information and materials
- Indicates how actually does the work and how to articulate the customer supplier relationships between functions.

The process approach is currently applied in conjunction with the theory Denim Cycle [5], which in principle suggests that the quality management processes generated by an activity must be cyclical and is in line with four stages: Plan, Do, Check and act. This means that an organization should always be improving corporate acting or correcting previously planned and done to improve it or what is the same as continually improving the management of the company, also allowing the products or services in the process of exploitation and consumption, become real laboratories that process.

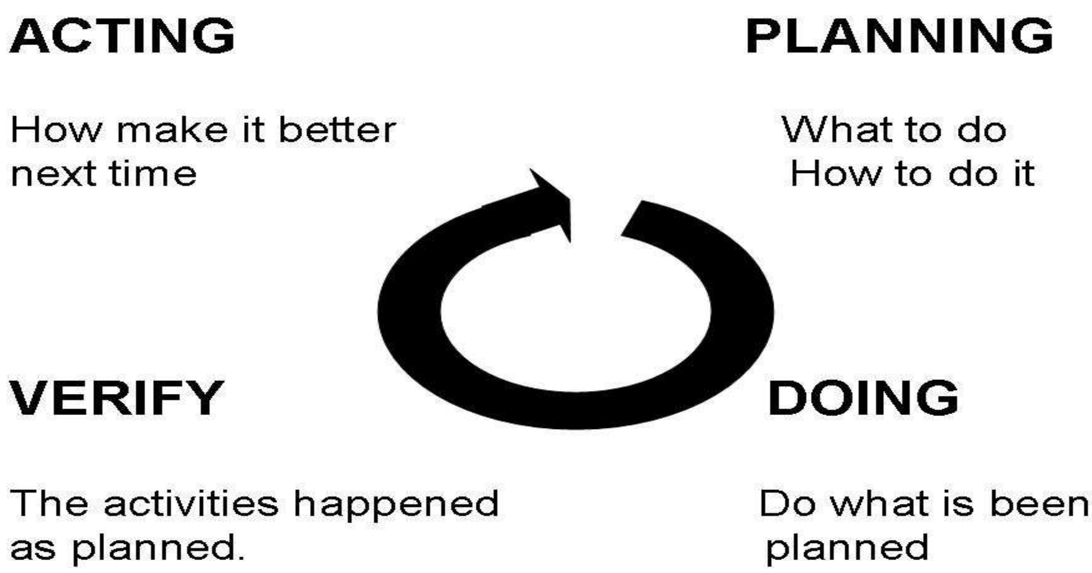


Fig. 4. Denim cycle

For the implementation of process management approach to an organization, it is essential among other things, create the necessary cognitive and technological conditions. Many companies take years to implement it in its entirety, and its implementation, first requires a thorough investigation of the behavior of all components of the organization in all its facets, or must do science. It also requires a strategy in the medium and long term. The most common is to be introduced in stages or subsystems, for example, sub-economic management, human resources, design, general services, production, etc.

Attached to this is to identify an approach is also used certification of compliance with its requirements. This certification is done internationally by the ISO, which assigns a panel of arbitrators or advisers, who are responsible in different countries to carry out the audit inspection process and, finally, after verifying in practice correspondence, from the extension of the certificate of quality compliance with ISO 9001 in the subsystem inspected. This certificate has an important significance, as it proves to other organizations or outside this sector, and society in general, the activity, product or service they perform, comply with all requirements necessary for the purpose with which designed and with high quality, that also increase the prestige of the organization to the international community.

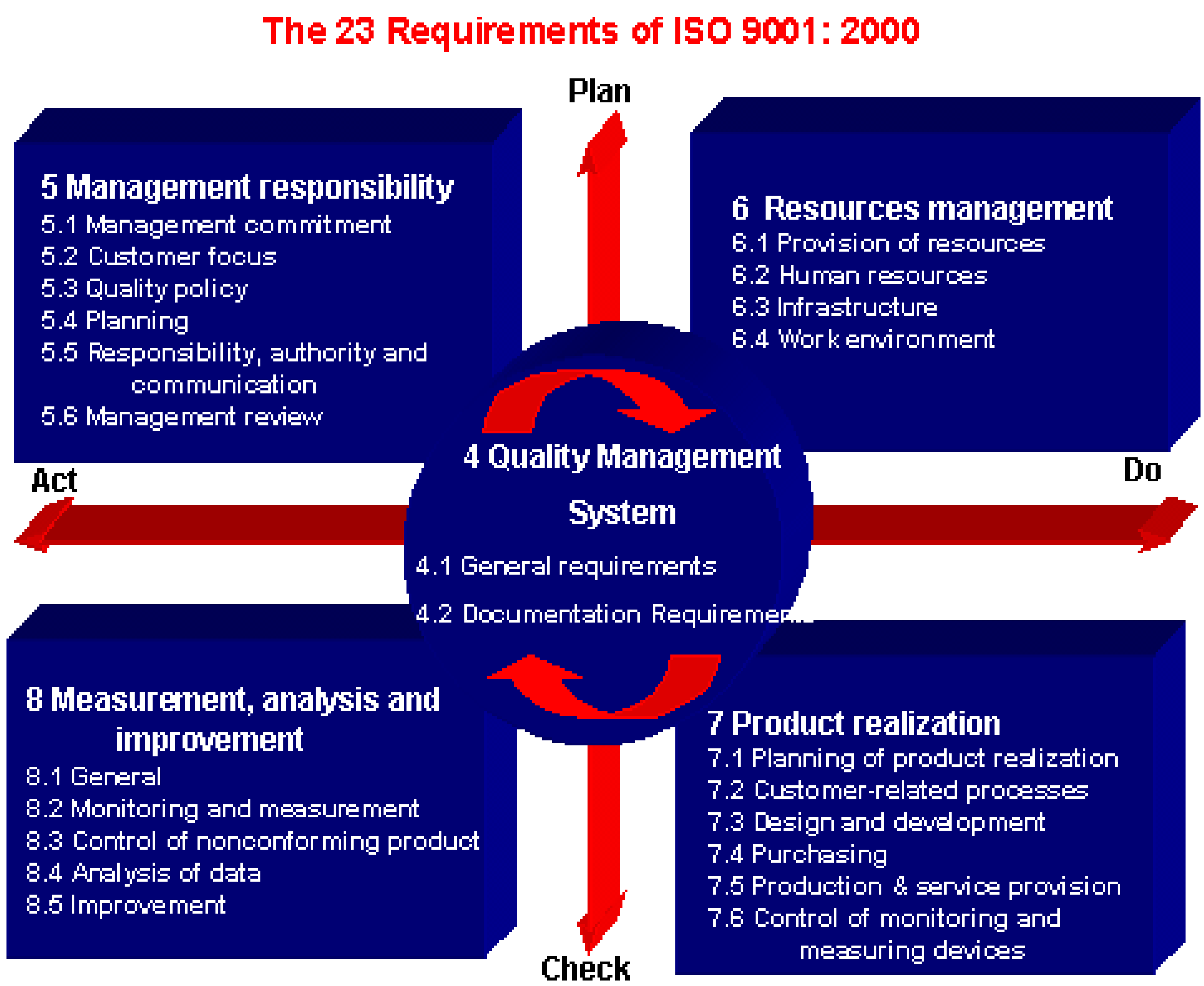


Fig. 5. Requirements of ISO 9001/2000

It should be noted that under the principle of managing processes in the world have been many working tools in various areas of human development, so much so that several of the ISO standards that emerged later, are also developed in the environment processes.

The current management of construction projects, regardless of their particular characteristics, is moving steadily towards process-based schemes, such as in the rest of the industry and services. These processes are not always well defined, lie necessarily in the implementation of quality systems and its far more classical definition (quality control, quality assurance) and involving the full set of activities to be developed. However, for the client of a construction project, there are certain processes that are more significant, in that they affect their own effectiveness as a manager, than others, which nevertheless still important in the entire business.

Perhaps the three most significant groups of processes for the customer are those relating to the economic control of the project (quantitative control), those that affect the quality of the product will receive (quality control) and, finally, the fulfillment of milestones in execution (control limits). The processes listed above, are supported by others who have most influence on those who carry out the project, such as the administration itself, the implementation of the various fractions of the project, etc.

The whole process generates a significant amount of documentation that must be preserved, distributed and evaluated. Contrary to the widespread view, this documentation should not have a volume greater than if quality systems are applied to production.

Transfers of technology in business management and management of geological risks to the developing countries, suggest the analysis of the technological, environmental conditions, social and economic conditions of each country. The advantage of representing the process management technology improves several aspects of business management, where the management of quality in their services or products is increased and enhanced in particular. International experience has acknowledged progress developer in the implementation of process management in various facets of economic and social development of countries, is considered a relatively young subject and novelty, which calls for more research to accurately set and increase aspects in the ISO standards, which do not include the management of geological hazards within their applications.

The management of geological risks is also a process that has certain peculiarities in civil engineering projects or hydraulic. If you need to understand the process approach, using its bases to the management of geological risks in these projects is developed, it is necessary interpret its components, such as "organization" would be the construction company executing the project construction or infrastructure the "customer" would be the investor, the "processes" are the stages of the project, the "threads" could be for example the seismic risk assessment in the preliminary stage, and the procedure could be the way to proceed with the seismic risk assessment. There is no difficulty in the interpretation and application of general principles of process approach to the management of geological risk in the construction processes and infrastructure, an issue that also pursue the same objectives of the approach and its advantages.
Taking into account that eventually the management of geological risks in construction and infrastructure works, which is looking to improve the final quality of them to be better able to withstand the geological events. You can say then that is correct adopt the principles of process management to model the geological risk management processes and infrastructure construction companies and develop institutions for them. In other words, this management can be implemented within a technological paradigm based on process management.

Model Proposition for geological risk management

The knowledge management model proposed in this contribution, part of the recognition of the need to improve the management of geological hazards in the construction processes and infrastructure, made by individuals and institutions directly or indirectly involved in them, and used for this description of the steps or actions in the threads that make diagnosis, design, implementation and evaluation. Its aim is to show the functionality of the indicators analyzed in stages or diagnostic procedures, design, implementation and evaluation, which can be developed to express and evaluate the organizational management of geological risk.

Moreover, this modeling is not inconsistent with the desires and objectives of the regulations in force internationally, the problem is that according to the analysis performed, there is no single technology model that meets the necessary requirements, enabling approved and unifying quality criteria as far as geological risk management concerns, and also follow international standard patterns for these issues since the project is conceived until its conclusion. The risk management model proposed geological, is functional at the same time, is a representation of what could be an alternative and inclusive knowledge management, which serves both the organization and its environment.

The proposition of the model is based on different aspects that must be met, and which form part of the international situation discussed above, these include:

- The investment process.
- The system of codes, rules and current legal regulations, which intervene in the management of geological risks.
- Processes management.
- The reality of the construction companies.
- The measures, regulations and national and local policies, proposed and implemented by the government and institutions.
- The international conventions and treaties on environment and disaster management.
- Multidisciplinary involvement in research and implementation of solutions.

The tasks to be carried in every action of the processes are subject to the conditions to be created in each organization and can be used various procedures and techniques such as Benchmarking, Reengineering, the SWOT matrix, among others.

Processes	Actions
Diagnosis	- Analysis of the current situation. - Establish working definitions. - Establish current strategic position. - Analysis of resources. - Requirements Analysis.
Design	- Development of strategy knowledge. - Definition of strategic goal. - Architectural design knowledge. - Creating organizational climate.
Implementation	- Implementation of the plans developed. - Revision of the strategy.
Evaluation	- Implementation of measurements. - Interpretation of results.

Table 1. General components of the model.

The resulting model of our research should follow the steps raised in a general methodology designed for different stages of project implementation, by adding to these the one conceived by Denim, or continuous improvement. So this methodology includes four stages of geological risk management, for whom and under what is deducted from the literature review, described then what are the key actions to be performed.

1. Preliminary Stage (diagnosis and design processes)
2. During the project implementation. (Part initial implementation)
3. Stage of project completion. (End of implementation)
4. Continuous improvement process. (Evaluation Process)

Preliminary Stage

At this stage the companies and institutions conceived the basic ideas of the project, perform diagnostics, designs, application for licenses, permits, contracts, literature review, etc. For the purposes of the model from two of its components:

Diagnosis Process

The aim of the diagnostic process is to determine the corporate resources that express the knowledge of the organization and its use to propose projects that allow the representation of organizational knowledge, their development and use in the qualitative improvement of the organization. The actions included in this general process are:

- Current Situation Analysis: The diagnosis is performed to know the current situation, the result of the completion of this process is to guide the action plans within the strategic development of the organization.
- Establish working definitions: It is necessary to establish a working definition of what each organization means knowledge. For an entity, can be "patent", in other capacities or also "experience". In our object of analysis, states that knowledge is reflected in documents, methodologies, procedures, reports, maps, etc. On the other hand has to do also with the participation of specialists from different disciplines, both in the pursuit of knowledge and the training of trainers.
- Set the current strategic position: It means identifying the level of access or knowledge barriers. This analysis provides the following categories: special, temporal and social. That is, where they reside (entities), what is the relevant time-frame of organizational memory, knowledge sharing, among others, and what is the hierarchical, functional and cultural context is contextualized, that which impedes or promotes the exchange of knowledge.
- Resource analysis: seeks to identify the categories of knowledge that exist, requires the identification of internal and external sources, such as research and development, relationships with other entities, sources that exist or are used in the organization, their relationships, the level which is currently and the level to be achieved.
- Requirements Analysis: Understand the requirements associated with implementing the project, analyzes the nature and the project environment, functionality and action plans.

At this stage, proposed to the specific management of geological risk carrying out the following:

1. To determine the social use of the work and general characteristics.
2. Make a diagnosis, which take into account the most relevant research results, the available historical information on the occurrence of significant events in certain localities with the resulting effects, or that is available in the institutional archives, the analysis of the difficulties in place to deal with a real natural phenomenon caused by man or the combination of these, besides all that useful information that could be taxed at a better management of geological risk (information management)
3. Analysis of the information provided by geological and engineering geological reports earlier reports from the study area or nearby, enabling management geological risk.
4. Analysis of data and information provided by the Geographic Information Systems.
5. Study of the surrounding environment, identification of key activities related to social and business discipline. (Socio-environmental risk management).
6. Study watersheds (surface and groundwater), their relationship to the threat of occurrence of severe weather events and the environment. Influence in the region of study. (Hydro geological risk management).
7. Selection of appropriate methods or techniques to analyze the information obtained.
8. Interpretation of the relationship between the occurrence of various natural and human phenomena possible to present the proposed work, which should lead to knowledge of the potential presence of danger and the behavior of the levels of vulnerability of areas of investment. Or more broadly stated, total identify threats, vulnerabilities and risks, identify possible single or combined (systematization of geological risk management).
9. Identification and review of the main rules governing the implementation of these activities.
10. Fabrication of the chips in the process, explained the contents and tasks of each thread of the model for this stage aimed at reducing vulnerability constructive.

The basis on which rests the whole structure of the integrated management of a construction, is the uniform treatment of information and capacity building of knowledge. This also means, uniformity in the processing of documentation, regardless of its source, its origin and its subsequent use (Serra - Pérez, 2007), the implementation of field investigations by specialists in preparing for interviews, surveys, assessments quantitative and qualitative economic, among other techniques, as well as in the training of technicians in areas related to process management.

The ease of use of databases and spreadsheets trade has meant that much information is treated by more and more people within the organization. However, well-managed construction organizations, tools for analyzing data sets are, with few exceptions, non-existent. It is rare to find tools to cross, for example, production data with quality, and even more difficult to analyze in some other way such data relationships. For these reasons should be narrow as well, which will be or what techniques or methods used to collect and analyze information, and what are the specialists who participate in this discussion, always valuing multidisciplinarity.

In the geological branch in the world are already being implemented tools such as databases that may well be used for risk management, which allow you to organize, process, transform and transmit information to the territory in question, quantitative data and formats, qualitative, logical and formal, so as to give adequate guidance for policies, strategies and plans for environmental sustainable within the country.

On the other hand at this stage includes the identification of the elements that characterize the geological risk and are represented in the bibliographic search and mapping, GIS and geological engineering reports. Is introduced as a factor in the social use of the work, for logical reasons to the determination of influence of the same on the geological environment, dynamic and static loads on the ground, pollution load, etc,. Note that as a tool mention GIS also can be used as previous research document or possess the scope to address the task, irrespective of those made specifically for investment in the implementation plan.

It is significant to note that reading about the vulnerability and the risk of geologists, geophysicists, hydrologists, engineers, planners, etc. can be very different from reading with people and communities at risk. It is therefore necessary to deepen also the knowledge about individual and collective perception of risk and to investigate the cultural and organizational development of companies that promote or impede the prevention and mitigation; aspects of fundamental importance to find efficient and effective means to succeed in reducing the impact of disasters caused by geological events.

Throughout the construction process, the rules have some point of application, it is necessary from this stage to identify what those involved in knowledge management and apply them properly, a key objective diagnosis. These are issues that should appear reflected in the records of the process.

Design Process

The objective of this process is to establish the rationale and technique to be developed on the various projects of knowledge in the organization. Includes the following:

1. Developing a knowledge strategy: Aimed at setting the course to enable the organization to go from current state to desired state. Aims to establish development plans and project management.
2. Defining a strategic goal: It aims to set the address to which projects are targeted. For a goal is met, must have the following characteristics:
    - Specific: clearly defined so that anyone can understand and know what is to be achieved.
    - Measurable: from proper design of the indicators.

- Consensus: This facilitates the response to changes that could involve the modification of a target as the project progresses. This consensus is based on sharing information and building commitment around the project.
- Real: It should reflect the actual scope around each of the factors involved in its development.
- Time frame: Requires a certain time frame, setting a reasonable goal according to the resources, knowledge and experience available.

Once defined, the goal should be broken down into objectives, depending on the level of performance to be raised. If the goals are verifiable, they should explicitly presents the achievements and deadlines to be met, i.e. should be described in terms that will generate strong indicators for assessing the associated implementations. Also bear in mind the context that explicitly defines the vision, goals, and corporate philosophy that represents the entire organization.

Corresponding to this is accomplished by designing architecture of knowledge: in order to establish elements:

- Investments in technology: identifying the needs-oriented support model components.
- The patterns of development or integration of the management model of geological risks: establish guidelines for the development and integration of knowledge management to support the process of geological risk management.
- The architecture of the model diagrams: organization and structure of quality control systems to support the model components.
- The organizational climate: aims to support strategically by management: the expected benefits, objectives and assumptions, developed strategy and its measures, and achieved expected results.
- Training: preparing scientific and technical staff who will speak both in execution and assessment processes and control provided for in the model.

At this stage, proposed to the specific management of geological risk carrying out the following:

1. Preparation and delivery of Geological Engineering Task. Study of physical-mechanical properties of soils and its relation to the information obtained earlier, the behavior of the project and surrounding loads, analysis of the geology and geo-environmental situation in general. This includes the analysis of geological engineering report updated taking into account variations in the behavior of soils and rocks, topography and other factors changing over time. (geotechnical risk management).
2. Identification and review of the main rules governing the implementation of these activities.
3. Preparation of preliminary report concluding geological risk management, which must include the results of all investigations in the field of engineering geology,

performed either by design engineers, for companies providing geotechnical services as well as their interpretation in terms of the work to be executed. This report provides a basis for making decisions necessary for the design and early implementation of the project, which include mitigation measures preliminary geological risk.

4. Assessment of cognitive development achieved by the technical staff on the geological risk, through different techniques.
5. Preliminary assessment of the effectiveness of the comprehensive measures taken on the basis of the work designed, geological and social environment.
6. Fabrication of the chips in the process, explained the contents and tasks of each thread of the model for this stage, aimed at reducing vulnerability constructive.

It is clear that the availability of information resources in a project does not necessarily guarantee the perfection of its use. The biggest problems are directly related to the effectiveness and efficiency of use and information management is the absence of their organization or their inconsistency. In line with this reasoning, we must consider the possible establishment of an internal program within the implementing institutions or companies to elevate the culture of information, questions relating to the necessary ongoing training of professionals and specialists.

It is possible that information obtained in the literature search, obtained the necessary elements enabling the designer himself prepare a geotechnical report for the work. It happens that in the archives of the institutions are the reports of previous works performed in the study areas, however, are not used, combine economic and administrative procedures unnecessary expensive single project.

According to Ayala (1992) to establish the types of geological hazards in any area in question is first necessary to establish the geological setting, which is basically a study morphological, sedimentological and tectonic elements focused on morph and establish a territory morph structural and its genesis, to establish the stratigraphy and sedimentary facies sedimentary tectonic structures identify, type, address and occupation thereof, and to know the physical properties of the geotechnical and geochemical types of sediment (soil). This geological setting allows identification of potential geological hazards.

Nevertheless, other factors also are factors to assess, these are the geo-environmental factors. The determination of geo-environmental factors, such as the presence of sedimentary instability, erosion and sedimentation rates, bottom currents, fluid dynamics, influence of atmospheric phenomena on the change of geological conditions, presence of gas, gas hydrates, etc.., helps to make a risk analysis with great precision.

The integration of the results obtained in the field of geological setting and geo-environmental factors can assess risk, in terms of frequency, extent affected by the risk and possible pollution due to the outbreak of the geological risk. This line of approach is relating to prevention efforts and agrees with the approach established by the Disaster Mitigation Program of the Agency for the Coordination of United Nations Disaster Relief-UNDRO[6,] and the scientific community.

As part of the successful completion of the model at this stage, ideally, for example, to flood areas with a certain lithology, there was an internal regulation of provincial construction group, to guide the builder types of foundations to be used, height must presented the beginning of the useful structure of the building or work of infrastructure, among other parameters. Process to be carried out by integrating all types of geological hazards present, so as to ensure effective mitigation of risk. These are matters which have already been working in the country by other specialists, and therefore are not analyzed in this research, even if their validity as example of concrete action.

In case of special requirements in the work to execute, it must request special reports geological risk assessment to institutions that specialize in such services, and implement the required mitigation measures and the preliminary evaluation of its effectiveness.

During the execution (Part initial implementation)

Implementation Process

This process aims to implement the project and establish its basic guidelines.
Includes:

1. Implementation plans developed: Each of the projects must be implemented according to schedule or plan.
2. Strategy Review: should be reviewed periodically, both goals and the objectives and plans associated with the strategy.
3. Fabrication of the chips in the process, explained the contents and tasks of each thread of the model.

Depending on the geological risk management is proposed to undertake the following actions:

- Practical implementation of the mitigation measures planned for the project geology in the preliminary report prepared in the previous stage.
- Realization of monitoring compliance with the technical and scheduled tasks on technological and productive processes designed in the project.
- Continuous evaluation of a system of indicators for project implementation, to ensure the management of geological risk at this stage of the work.
- Preliminary assessment of the effectiveness of risk mitigation measures taken on the basis of geological work in the implementation process.

At this stage, which falls during the execution of the project, geological risk management is closely related to geotechnical testing, i.e. the physical-mechanical properties of the soils and rocks under study and the implementation of mitigation measures determined in preliminary studies in the first stage.

An indicator allows monitoring and periodic evaluation of key variables or indicators of risk management through comparisons with their internal and external referents. The indicators are evaluated must also see to the implementation of environmental or ecological traps, and techniques during the process of land preparation, proper authorization and rehinchos stuffed, cut and natural slopes, design and implementation of the excavations, the design and implementation of foundations, hydraulics, electrical, and others who will be buried, to carry out works of protection, quality completion of phases, including:

1. Human alterations of the landscape.
2. Induced instabilities and landslides.
3. Changes of content in phreatic level and humidity.
4. Observation onsite of the behavior of charges projected onto the soil.
5. Changes or variations in the initial design of the project.
6. Analysis of soil conditions in buildings in different processes. (Referring to works that are the subject of rehabilitation, remodeling or maintenance, changes of uses of works or objects of work, and changes in environmental conditions, etc.).

There is no set limit on the evaluation of indicators, the more they are the better for the work, as they may be risk factors if not taken into account during the execution of it, a more complete description of these aspects is not objective of this research, this is a task that construction specialists have ahead to solve.

Project Completion Stage (Final part of implementation)

At this stage not "last", it stops being less important the task of managing geohazards in it there are certain actions that also need to look closely as practical experience and visual observation made for this research, need to say so:

1. Assess the implementation of a system of indicators for the completion of the project investor, to ensure the management of geological risk at this stage of the work.
2. Final evaluation of the effectiveness of risk mitigation measures taken on the basis of geological work in the process of completion.
3. Prepare recommendations for efficient operation of the equipment installed in compliance with the geological aspects.

At this stage of completion, the assessment is related indicators, for example, the analysis of the atmosphere works. Many times in our buildings do not work correctly applied the appropriate atmosphere and garden, and we do not foresee the future risk that they may bring works in progress of completion, partly for lack of knowledge about the physical-mechanical properties of soils insitu and filling by specialists in gardening or background, and partly because of lack of guidance from engineers involved in the execution of the work directly on these issues.

As a result, going from a few years begin in the buildings directly affected by the growth of root systems, which manifest themselves in various ways such as: cracking, subsidence, building of walls, exterior walls and interior structures, and even the collapse of these structures.

These effects occur due to the characteristics of the soil, providing nutrients needed for plant development, a process that often increases as a geologic event occur such as floods or earthquakes, which in the case of first increases in soil properties such as porosity and pore rate, reduces compaction, and promotes the increase of plastic properties and the second, and increase the plastic characteristics of the soil, increases moisture and liquid content, being all these consequences, favorable factors for the development of plants and their root systems (root length, nutrient solution and water for its development.)

To avoid these phenomena is also necessary to manage this risk in the process of completing the work, and even promote actions for the cognitive growth of these elements in setting workers, and technicians and engineers about their work, so that there is a feedback between them.

It is necessary for having gained extensive knowledge in the course of the previous stages, and is even on the geological risk and how they managed correctly for each construction, infrastructure work or subject-specific work, this is described by a report and given to future utility, with a set of recommendations for the efficient operation of the equipment installed in compliance with the geological aspects are identified and managed during execution.

This is a very important for construction companies, allowing them to among other things, take a highly technical and responsible position in the field of geological hazards. On the other hand, it also permits the protection of technological knowledge for the perpetrators, protect its reputation in the community and contribute to successful and appropriate future use of the work in question.

Continuous improvement process (process evaluation)

Evaluation Process

Its objective is to assess the results of the implementation of projects, to validate the strategy of knowledge and diagnostic feedback to the process. This process provides that, once the implementation of projects and their plans, they must be evaluated by a number of management measures, and this will show the results in the incorporation of mitigation measures in the context the project.

It should be narrow, that each completed project is a virtual laboratory for the construction company, as the continuous improvement includes both aspects of this work as benchmarking with other works carried out. Allow internal comparisons show the progress from the historical perspective of the vision of designer and executor. However, a comparison with the outside will show the real impact of progress, because it allows comparison of the relative effectiveness in the management of geological hazards.

To perform these evaluations, different modalities can be applied:

- Quantitative measurements: pre-defined variables and that have meaning.
- Qualitative measures: through non-numerical methods.
- Observation: corresponds to the views of the staff previously trained to evaluate issues of concern.

This process includes:

1. Implementation of the measurements: Definition of method and technique to obtain information and execute measurements according to the defined actions to obtain the necessary information.
2. Interpretation of results: Includes the processing and analysis of the data to determine the type of geological hazard for which the indicator was created. Depending on the volume of information can be validated using the selected tool.
3. Continuous Improvement: involves applying the principles of analysis provided for in Denim cycle, consisting of evaluating potential errors or improvements to the procedures, techniques or technologies used in the work. This technique applies both during implementation and during operation, and it aims to improve all processes running on the play in terms of both itself and improve them in future projects.

Under this conception, the works carried out are the practical laboratory of companies implementing or controlling the processes of geological risk management. This still enables the conduct of mitigation measures applicable to future projects, and improvements in the works already completed or in process maintenance, rehabilitation or remodeling.

Graphical expression of the geological risk management model for construction and infrastructure processes

After having described the steps that will be present in the model, having made a thorough analysis of the elements that make up the geological risk in particular, to analyze further how day geological risk is managed from the point of view institutions and legal regulations involved in this process and describe the procedures of the model, it is appropriate to make a graphical representation of it:

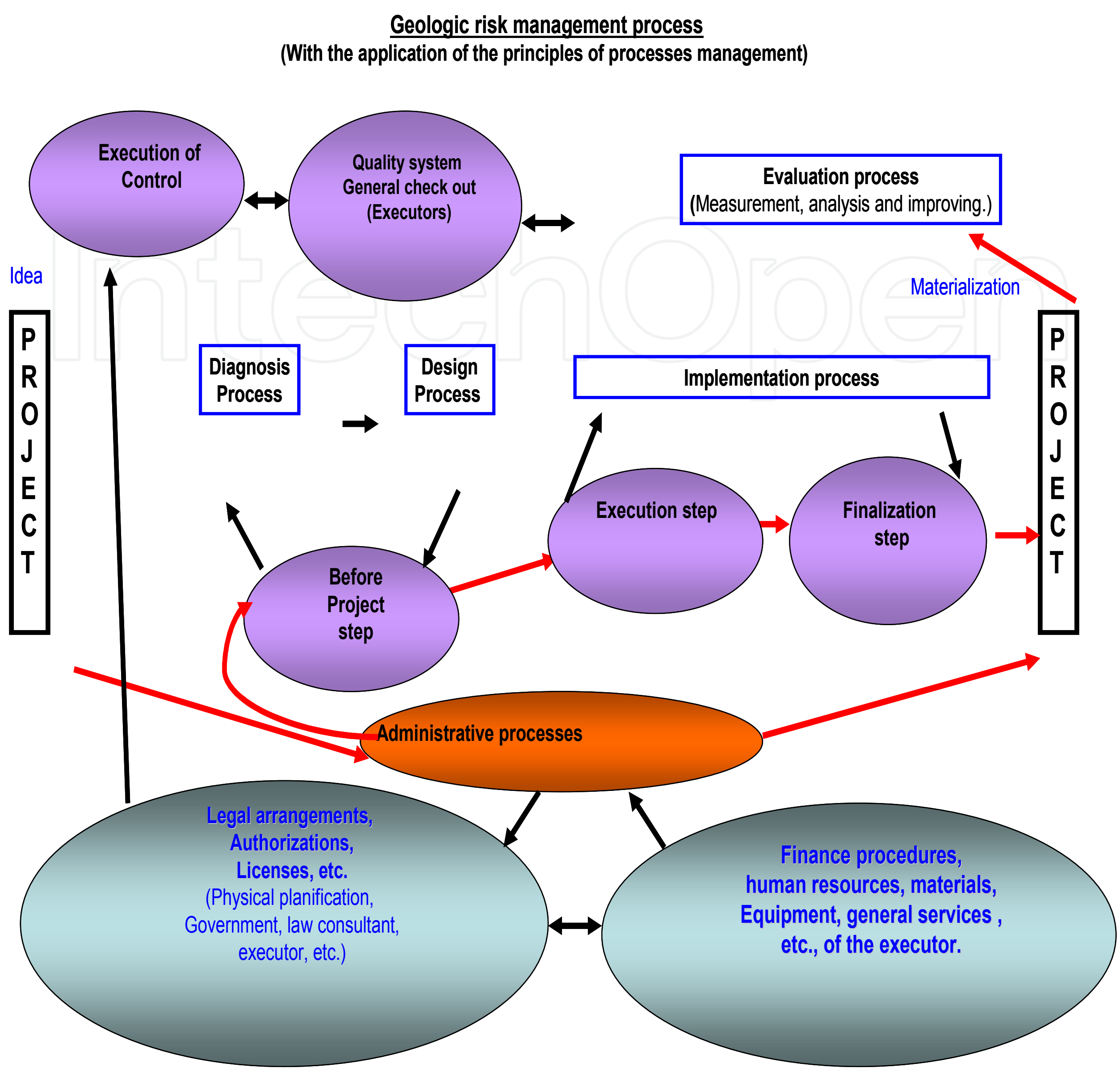


Fig. 6. Model for geological risk management in construction and infrastructure processes.

The model explains three types of fundamental processes:

1. The administrative, that are intended to ensure the management of human resources, financial and material (bottom).
2. The principal managers of the geological risk: which are interconnected by the methodological steps proposed in this research.
3. The executive control and continuous improvement: for the control that those responsible companies and engineers are executing on the execution of all activities related to the project, geological risk management on an ongoing basis (at the top).

We believe it is significant to state that this model is a dynamic model. The processes indicated in the management, may or may not be applied in correspondence with the type and size of investment, as well as the assessment is made of time of use of the work. Just as other aspects may include consideration of the executor are important risk factors to be managed.

It can see that the process of geological risk management is a complex process where several factors, which in the end always help to assess the magnitude of risk and vulnerability and cumulative, and in this way make timely technological measures necessary for success, durability and security of investment and infrastructure construction, which is printed therefore more sustainable development constructive and life safety.

The successful implementation of the model lies not only in knowledge of the steps, stages or threads that shape it, but also in the interpretation efficiency geodynamic situation described and provided by the various documents, information contained in GIS, tabs and others, who are able to obtain the executing engineers and investors in the region, area or locality where the work is located and also the correct application of the rules, regulations and technical measures contained in the various ministries, regardless of its shortcomings.

Each of the above analysis involves uncertainties and limitations that are reflected in the final application of mitigation of geological risks, which must be taken into account when interpreting the results of the staff responsible for implementation. These potential limitations include:

- Inadequate search of information needed to manage the geological risk.
- Do not apply the provisions of the various building regulations, rules geotechnical, seismic or other.
- Do not apply the issues raised in the various resolutions, plans and regulations currently existing in the environment, technology, civil defense, construction, etc.
- No other measures that are not listed in these sections and which may form part of the introduction of new technologies either by transfer or by innovations made in connection with the work.
- Do not make the necessary executive and technical control compliance activities described in the management of geological risk for processes and threads.
- Do not apply the different variables are and can be introduced to the model in correspondence with the type, nature and extent of the constructive or infrastructure to run.
- Failure to make a good staff training on issues related to both the geological risk management, and the application of the model during the construction process.
- Do not consider the process of continuous improvement as part of the management of geological risk.
- Not adequately prepare the files of the processes and under process.

The limitations to the application of this model are highly dependent on subjective factors that have to do with the knowledge to meet the task ahead, preparation of staff and with effective control of the actors of the investment process. This is the key to ultimate success and quality assurance in the implementation of geologic risk mitigation measures.

Methodology of implementation of the model

To implement the management model of geological risks in an organization requires the implementation of a methodology and strategy. Implementing the strategy involves conducting a series of actions will be met through the methodology and procedures established for that purpose.

This strategy is tailored to each organization in correspondence with the analysis of the factual situation that is real, which means that its implementation depends on the internal characteristics of the organization, its corporate purpose, level of training of staff to plunge homework, etc.. The strategy should also optimize the balance between quality, time and cost, according to the priorities assigned to each of these variables.

The implementation methodology consists of four steps, differentiated by the objective pursued in each of them:

- First: Identifying and assessing the current state: it corresponds with the diagnosis and inventories of resources and services that are available both as identifying those that can be implemented through the implementation of various projects.
- Second: Definition of goals: establishing a diagnosis made according to and knowledge of organizational behavior. Therefore, as part of the design process, it is proposed to implement the model for the management of geological risks so as to focus its efforts in the allocation of content that realistically reflects the potential of knowledge within the organization.
- Third: Project development: it takes place after the implementation of the actions of the strategy designed for that purpose and which will gradually incorporate mitigation measures geological risk, as structured in different phases and applications to express knowledge of the organization and its relationship with the environment.
- Fourth: Analysis of results: examines the correspondence between the results of determining the current state with the goals that define the organization and the definition of the projects carried out to establish the differences that must be given a new diagnosis.

As an indispensable element and prior to the successful implementation of the methodology, it should ensure the effective engagement of the direction of the company as a rector of any change, and employees as direct and decisive factor in realizing the process improvement.

Set to the methodology steps 1, 2 and 3 are made by members of the management of the company, which will oversee the overall development of it.

The first step of the methodology should provide inter alia for internal and external analysis, which comes from the direction of the company, and where research should focus broadly on what factors are influencing the actions of the system, identifying results, effects of daily management, etc. This will differentiate the results that are the product of external factors and those from internal.

For this analysis should be selected and formed an interdisciplinary team which has the following characteristics: (Negrin, 2006)

- Consist of between seven and 15 people. ((Recommended 9)
- Ensuring the diversity of knowledge of team members.
- Some of the members have to be experts in management systems
- Having the presence of an external expert on geological hazards.
- Appoint a member of the Management and Coordinator of the team.

The proposed technique for the analysis is brainstorming, which will be held for each functional area and level of the entire project. This step will be the starting point for an analysis of the processes inside the company and will detail the problems of each process, based on the application of the methodology, and will identify whether the factors that must be improved causal relationship on the effects or results of the geological risk management. To identify and define the goals in the organization is necessary to take into account certain issues:

1. There must be a contrast with the strategic objectives of the company.
2. Must meet the needs of clients of the investment process, understanding as such all persons or entities own or outside the company, which receive some of the outputs of the process.
3. They must meet the expectations of the management process of geological risks during the construction process and infrastructure.
4. Should be addressed to improve in the management of the final quality of the work and the recognition in the community of the administration by the company executing the project.
5. Should take into account material weaknesses and problems related to human resources.

During the development of the project the team designated to carry out each process, thus arises the need to define indicators for geological risk management in response to the following questions:

- What should we measure?
- Where should you measure?
- When should I measure? At what time or how often?
- Who should measure?
- How should you measure?
- How do they have to disseminate the results?
- Who and how often you will review and / or audit the data collection system?

Where the first work to be done with these indicators is to realize the objectives of all the indicators defined in the previous phase, so these are consistent with the basic objectives of the process and ensure compliance.

As discussed above, the model suggests some of the key indicators for the management of geological risk, of course the objective reality of the construction process, the company and the environment, will show which of these are the most efficient, and if described in the model are appropriate or necessary to its growth.

The process should be evaluated periodically. This is a very important aspect is often forgotten by staff blamed in developing this type of activity. The assessment of performance of a process, reference must be made on a pattern of functional excellence This pattern of comparison to be made from desirable or optimal behavior of a set of measuring the performance of processes in the world's leading construction companies, or alternatively in the Cuban construction companies with similar processes in order to study, with proven success in performance. All this by a synthetic indicator, which when calculated in quantitative terms to identify the gaps between the actual level of the meters and their desired trend, which makes it possible to define specific problems in all dimensions of the process.

An important issue that can effectively introduce mitigation of geological risks in construction projects and infrastructure construction is the evaluation and selection of alternatives for improvement. Process Team to evaluate possible actions to take to solve the problems that have the greatest impact on the performance of the process, taking into account the feasibility of comprehensive implementation and its impact on the whole system under these conditions prepares a draft improvement plan with responsibilities and deadlines, in order to define and validate how to implement the improvement, that is the measure of geological risk mitigation.

To efficiently solve the latter issue, the process analysis team may use some of the tools provided in the following management processes:

- Troubleshooting: This application is applied locally to the selected activities as long as the information is specific enough to describe the object or location is detected and the particular defect that occurs. Any tool related to the resolution of problems is valid.
- Technical value: To identify possible wastage of the current process, we proceed to apply this technique to all the process activities identified with some degree of difficulty, systematically questioning all of them. Be sufficient to make the following questions in a first approximation (If necessary, resort to using the tool in all its depth):

  Does it contribute to increase the quality and safety of the work?

  Does it contribute to meeting the needs of the client or investor?

  Does it contribute to achieve one of the strategic objectives? etc.

- Gather external information related to the process or activity thereof. Depending on the extent of the process may be interesting to divide the work of capture and analysis of information between different team members, the sources indicated in the model.

After selecting or selected improvement alternatives, it is necessary to establish the improvement plan at this stage is part of the results of which have been defined above problems have a greater impact on the process individually and as expanded on the strategic objectives of the companies and also the real possibility of giving a viable solution for the company in the short term, so we proceed to define a plan of improvements to the final process with the highest degree of detail, which include action to take, material resources, financial and human resources to employ, directly responsible for implementing the improvement and the impact this will have on the process and organization
To implement the improvement alternatives is implemented the improvement plan previously defined, the implementation may last longer, so it is necessary to develop a concrete plan with defined responsibilities, deadlines for each of the objectives of proposed improvements.

The implementation phase of improvements to the process requires that the Department will approve the proposed direct interaction with all workers involved in the process (workers, technicians and managers). Before implementing the new process is necessary to think about possible resistance change and possible countermeasures to be adopted among which are the following: (Negrin, 2006)

- Communicate and involve people who will be involved in the implementation of improvements.
- Provide education and training necessary
- choose the right Timing
- Develop a progressive implementation of improvements, trying to start this with the most receptive and the most prestigious among their peers.

Prior to implementation, is introduced to the company's usual (procedures, instructions, rules, etc.) Changes associated with improvements in order to consolidate the changes and avoid internal contradictions.

May be used in the analysis of results, different methods of assessment have been described in the literature, such as SWOT matrix to facilitate knowledge management.
The steps of the methodology are not closed systems, but are enriched by the ideas, according to the needs of each organization in which methodology is used, but always considering that the instruments are implemented and planned actions that respond to the objectives sought in each, these established principles of process management.
To monitor and evaluate the results, the improvement team responsible driving the implementation of the Plan of Implementation, compliance controls and evaluates the effectiveness of the work done by monitoring the results achieved, and performing periodic filings with the management of the company , head of compliance plan process improvements.

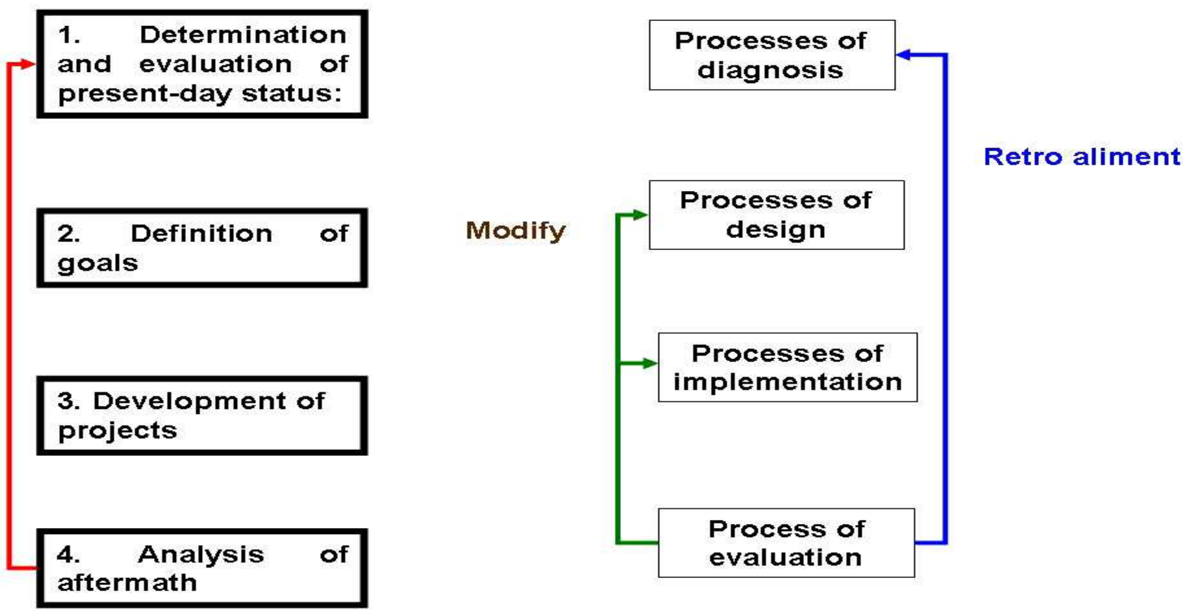


Fig. 7. Structure of the methodology.

The application of the methodology is systemic and cyclical nature because the assessment is a diagnostic feedback and modifies the actions to be undertaken, both from the point of view of knowledge as its architecture as shown in Figure 7.

The application of the geological risk management under the principles of process management is also cyclical raw satisfaction of stakeholders in the final product that our case is the constructive or infrastructure quality in the final involving mitigation of geological hazards and the improvement process.

Conclusions

The model aims to provide new ideas on the management of geological risks in the construction and infrastructure processes, so that as a proposition is introduced into the investment process is carried out in different countries, from its legal body, in a manner that establish a requirement for active and passive actors in this process, this would be in the author's opinion, the best way to establish a way to ensure sustainability of building development in the medium and long term. This also would avoid the large outlay of money and resources that the states have to pay or release each year, after the frequent occurrence of natural and technological disasters.

It is relevant to mention that as a model of technological innovation, this model is dynamic, allowing for interaction between actors and resource persons. Its main limitations depend on how deep or not be covered by the interdisciplinarity participation, to what extent would be apply or not the different management tools, as well as aspects related to the introduction of technology transfer and / or innovations in the process.

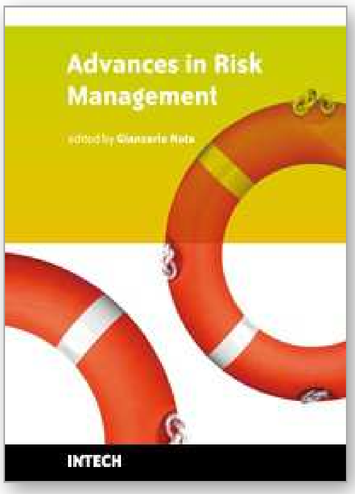
The methodology presented to validate the model, start of the criteria expressed by the experts consulted during the research, the actual situation of the companies executing projects in Cuba, which are introducing gradually Principles of process management into their systems and subsystems.
The methodology raises the application of the model with a cyclical and interactive character, where is prevailing the training and group decision, and the individual insistence in administrative control at every stage of the work and, overall, corporate actions, which are developed to finally make a proper geological risk management in the constructive and infrastructure processes.

References

1. AYALA C. 1992. Introducción a los riesgos geológicos. Instituto Geológico y Minero de España. Editorial Ríos Rosa, 23. 28003. Madrid.
2. AYALA CARCEDO, F.J. y OLCINA CANTOS, J. 2002. Riesgos Naturales. Editorial Ariel, Barcelona. ISBN 84-344-8034-4.
3. Bieri, Stephan, 2005 Disaster Risk Management and the Systems Approach. *http://www.drmonline.net./drmlibrary/pdfs/systemsapproach.pdf*. Consultado en Diciembre 2007.
4. Cardona, Omar Darío A. (2001) *Evaluación de la amenaza, la vulnerabilidad y el riesgo. "Elementos para el Ordenamiento y la Planeación del Desarrollo".* Red de estudios sociales en Prevención de desastres en América Latina. Bogotá. Colombia. http://www.desenredando.org/public/libros. Consultado en Junio del 2006.
5. Chuy Rodríguez, Tomás J.; Puente González, Guillermo. 2005. Impacto de fenómenos naturales. Una valoración imprescindible para el desarrollo sostenible de zonas costeras de Santiago de Cuba. Obtenido en formato electrónico en Centro de Estudios de Manejo Costero. Universidad de Oriente. Santiago de Cuba.
6. Colectivo de autores, 2005. "EXELENCIA EMPRESARIAL, Por qué la gestión por procesos", España. http://web.jet.es/amozarrain/index.html. Consultado en Marzo 2008.
7. Colectivo de autores. 1999. Tecnología y sociedad. Grupo de Estudios Sociales de la Tecnología (GEST). Editorial Félix Varela, La Habana. Cuba.
8. Colectivo de autores. 2005. Guía ambiental para obras de prevención y mitigación de riesgos. Quinta Parte. Organización Panamericana de la Salud. Biblioteca virtual de desarrollo sostenible y salud ambiental.
   www.bvsde.paho.org/bvsacd/cd65/GuiaAmbiental/biblio.pdf. Consultado en octubre 2007.
9. Concepción Suárez, Ramiro. 2003. Metodología de Gestión de Proyectos en las Administraciones Públicas según ISO 10.006
   Localización. http://dialnet.unirioja.es/servlet/oaites?codigo=1434. Consultado en octubre 2007.
10. Crespo Villalaz, Carlos. 2004. Mecánica de suelos y cimentaciones. 5ta.Edición. Editorial Limusa, Noriega editores. España. ISBN: 9681864891, 9789681864897. Dionisio Pérez-Villar. El concepto de Gestión del Conocimiento.
    http://www.gestiopolis.com/canales6/ger/la-gestion-del-conocimiento.htm,
    Consultado en noviembre 2007

11. Fournier, d'Albe E. M. 1985., "The Quantification of Seismic Hazard for the Purposes of Risk Assessment", International Conference on Reconstruction, Restauration and Urban Planning of Towns and Regions in Seismic Prone Areas, Skopje. Obtenido en formato electrónico.
12. Fundamentos de Administración Financiera. J. Fred Weston, Eugene F. Brighan. Mc Graw - Hill. 1994. Galbán Rodríguez, Liber(1). 2009. Algunas consideraciones sobre la introducción de las nuevas tendencias internacionales en materia de gestión de riesgos geológicos, en la enseñanza de la ingeniería hidráulica y ambiental en Cuba. Ponencia presentada el 7mo. Congreso Provincial de Educación Superior.
13. Universidad 2010. Junio, 2009. Palacio de Convenciones Heredia. Santiago de Cuba. Cuba.
14. Galbán Rodríguez, Liber(2). 2009. Algunas consideraciones teóricas sobre la gestión de riesgos geológicos. Revista de Geología UFC. Volúmen 22, Número 1. Brasil. ISSN-0103-2410
15. Galbán Rodríguez, Liber(3). 2009. Algunas reflexiones sobre las causas que generan el riesgo geológico en la provincia Santiago de Cuba. CD ROM "III Taller Internacional Nuestro Caribe en el Nuevo Milenio". ISBN: 978-959-207-357-9.
16. Galbán Rodríguez, Liber(4). 2009. El modelo de gestión por procesos en la evaluación de riesgo geológico en la provincia Santiago de Cuba. Un ensayo preliminar. Rev. Mapping, ISSN 1131-9100, Nº 132, 2009 , pags. 18-23. España. http://dialnet.unirioja.es/servlet/articulo?codigo=2913108 Referenciada en: LATINDEX, COMPLUDOC, DIALNET.
17. Galbán Rodríguez, Liber(5). 2009. Modelo para la gestión del riesgo geológico en los procesos constructivos y de infraestructura. Revista de Obras Públicas: Organo profesional de los ingenieros de caminos, canales y puertos, ISSN 0034-8619, Nº. 3500, 2009, pags. 39-50. España. Referenciada en: COMPENDEX, COMPLUDOC, GEOREF, ISOC, ICYT, LATINDEX, TRANSPORT, TECNOCIENCIA , DIALNET.
18. Galbán Rodríguez, Liber(6). 2009. Problemas sociales que enfrenta la gestión de riesgos geológicos en los procesos constructivos y de infraestructura en Cuba. http://www.monografias.com/trabajos75/problemas-sociales-gestion-riesgos-geologicos/problemas-sociales-gestion-riesgos-geologicos.shtml
19. Galbán Rodríguez, Liber (7). Conferencias del Curso Geología para Ingenieros. 2008. http://webserver.fco.uo.edu.cu/uoclas/LGR
20. Galbán Rodríguez, Liber(8); Galbán Rodríguez, Liuba; Vázquez Pérez, Ársul José; Gago Abad, Adrián. 2010. Reflexiones en materia de gestión de riesgos geológicos en procesos constructivos del municipio Santiago de Cuba: Normas y procedimientos jurídicos. Revista Jurídicas. Vol.27/3, 2010. Colombia. ISSN: 1794-2918
21. Iturralde-Vinent, Manuel A.; González Raynal, Bertha E.; Chuy Rodríguez, Tomás. Riesgos naturales de origen geológico. 2006, www.medioambiente.cu/uptnatgeo/index1.htm. Consultado en diciembre 2007.
22. Keller, E. (1995): Enviromental Geology. Prentice may, New Jersey, 560pp.
23. Kiroiwa, Julio. 2002. Reducción de desastres: Viviendo en armonía con la naturaleza. Editorial Quebecor World, Perú S.A. ISBN 9972-9477-0-X
24. Koontz, Harold y Weihrich Heinz. *Administración, una prospectiva global.* Editorial McGraw-Hill, 11ª. edición, México, 1998.

25. M. Y. Dikdan Jaua. 2003. Modelo de aseguramiento de la calidad en el diseño y construcción de desarrollos masivos de viviendas de interés social. VII Congreso Latinoamericano de Patología de la Construcción y IX Congreso de Control de Calidad en la Construcción. CONPAT 2003, Vol. I: Control de Calidad, Capítulo VIII : Gestión, Trabajo VE01 pp. VIII. 9 - VIII. 16. ISBN 968-464-133-8. Mérida, Yucatán, México
26. Mendioroz Jauge, D. Ricardo et al. 2003. "Gestión Integral de Obra",III Congreso Andaluz de Carreteras. España. Obtenido en formato electrónico en Centro Territorial de Gestión de la Información del MICONS, Santiago de Cuba.
27. Monge Granados, Hernando. 2003."La construcción de proyectos de infraestructura multinacionales en Centroamérica y sus consecuencias en la generación de riesgos". Costa Rica. Obtenido en formato electrónico en Centro Territorial de Gestión de la Información del MICONS, Santiago de Cuba.
28. National Academy Of Sciences, Earthquake Prediction and Public Policy, Commission on Sociotechnical Systems, National Research Council, Washington, 1975.
29. Negrin, Ernesto. 2006. "Metodología para el perfeccionamiento de los procesos en empresas hoteleras". Consultado en noviembre 2008. http://www.monografias.com/trabajos10/hotel/hotel.shtml.
30. Norma ISO 9001-2001. Obtenido en formato electrónico en Centro Territorial de Gestión de la Información del MICONS, Santiago de Cuba, 2008.
31. Perkings J. B. y otros, "Liability of Local Government for Earthquake Hazards and Losses - A Guide to the Law and its Impacts in the States of California, Alaska, Utah and Washington", ABAG, Oakland, 1989.
32. Quarantelli, Enrico L. 1992. Urban vulnerability and technological hazards in developing countries societies. Washington DC. USA. Obtenido en formato electrónico en Centro Territorial de Gestión de la Información del MICONS, Santiago de Cuba, 2008.
33. Rico de Calvío Fundasal, Gilma Zulema. 2005. Hacia una metodología para la gestión del riesgo en comunidades marginales. Consultado en octubre 2007. www.yorku.ca/ishd/RICOdeCALVIO.pdf.
34. Soto Balbón MA, Barrios Fernández NM. 2006. Gestión del conocimiento. Parte II. Modelo de gestión por procesos. Acimed. http://bvs.sld.cu/revistas/aci/vol14_3_06/aci05306.htm. Consultado en Julio 2008.
35. Spence, R.J.S. 1990."Seismic Risk Modelling - A review of Methods", contribution to "Velso il New Planning", University of Naples, Papers of Martin Centre for Architectural and Urban Studies, Cambridge. Obtenido en formato electrónico en Centro Territorial de Gestión de la Información del MICONS, Santiago de Cuba.
36. Starr, C., "Social Benefit vs. Technical Risk", *Science*, American Association for the Advancement of Science, Vol. 165, Sept. 1969.
37. UNDRO, "Natural Disasters and Vulnerability Analysis", Report of Experts Group Meeting, Geneva, July 1979.
38. Zucchetti, Anna et al. 2008. Guía Metodológica para el Ordenamiento Territorial y la Gestión de Riesgos. Equipo Técnico Grupo GEA. www.grupogea.org.pe. Depósito Legal: 2008-05506, HS Number: HS/983/08S, ISBN Number:(Volume) 978-92-1-131966-8. Lima, Peru.



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